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Technology and Intelligent Transportation Systems (ITS): The Implications for Future Transportation

Background

A review of the technological advancements occurring today suggests that many diverse solutions appear available to solve this congestion problem. Yet, the ultimate survivor in the quest for congestion-reducing transportation technology will be the innovation that profitably addresses four different dimensions of resistance within the current transportation system:

1. The driver's desire to travel farther, faster, independently and on an individualized schedule.
2. The manufacturers' and transportation planners' vested interest in minimizing adaptations of the current vehicular systems.
3. The cost of infrastructural changes imposed on transportation planning organizations.
4. The need for fast, inexpensive movement of labor and goods within a globalized economy.

This report presents an economics-based overview of the current status of transportation technology. Since this report does not pretend to be a meticulous engineering dissertation—the

goal is different from what many transportation analysts may be expecting. The goal of this report is to merge the current state of transportation engineering with the technological and economic trends that are currently in the midst of a churning state of evolution. Thus, it provides analysts insight into the technological evolutions that are most likely to survive within the transportation engineering systems of the future.

Second, the report offers an overview of the current innovative research occurring around the world in the field of Intelligent Transportation Systems (ITS). An excellent, up-to-the-minute synopsis is presented on the Internet by Jerry Schneider of University of Washington. Much of the groundwork for this section is drawn from Schneider's work.

Lastly, the report introduces a method of evaluating the most probable victors in ITS technology. This evaluation includes the results of a survey of six experts within the field of ITS. Also, a schematic is presented to quantify the strength of many of the current innovative technologies in relation to the four dimensions of resistance mentioned above.

Approach

This report evaluates the most probable technologies to triumph within future Intelligent Transportation Systems. This evaluation involves two steps. First, current and emerging technologies are “weeded out” by applying VisionEcon’s process for measuring multi-dimensional resistance factors. Second, these results are merged with the results of a survey of six experts within the field of ITS. While many ITS experts may be tempted to dismiss the results of this futuristic outlook as whimsical, it is conventional wisdom that business leaders have often been caught off guard by transformations occurring outside their area of expertise. [One only needs to look at the computer expert’s forecast in 1943 that there was “a world market for maybe five computers”.] And yet, these peripheral changes that are occurring often have immense and lasting effects on the way the world works.

Findings

Based on the analysis of the literature and the expert responses to the survey, the following seven technological developments seem most probable.

GPS: Global positioning systems (GPS) are here to stay. In fact, technologies that integrate GPS with routing decisions, GIS mapping or other applications will begin to proliferate. A great example of the importance of GPS comes from an industry that has been very resistant to change since the middle of the last century. Since the 1950s, the railroad industry has not evolved much. Yet, today the railroads are using streams of data including GPS to tell of a train’s condition and location.

Telematics: In order to support an interactive environment between vehicles and the transportation infrastructure on which they are transported, vehicles MUST be connected. Thus, the telematics fields promise to be areas of great innovation and promise. A great example of such a network was achieved in December 2001 by the Munich-based company Definien. Fifty cars were equipped with GPS, radio

modems and car PCs. The cars sent images and messages between them and the system used this information to assign them to certain road sections. This decentralized traffic routing system optimized the route guidance even with only one percent of all vehicles equipped. This work builds on another automation project, CHAUFFEUR, executed in Germany in 1999 where a lead truck was followed by a second truck under fully automated control on public highways. Funded by the European Commission, CHAUFFEUR II began in early 2001. Hence, more improvements will be on the way.

Adaptive Cruise Control and Other Collision Avoidance Systems: One of the requirements of cooperative vehicle-highway systems is that information is collected on traffic conditions, and this information provides input into the algorithms that dictate speed or other repetitive driving actions. Without these external interventions, nothing will change on the congestion side of traffic management. However, due to resistance, liability and security concerns, individuals will always want the option of buying out of the new technology. Freedom and individuality will always be the key to participation in any new transportation systems.

This area of cooperative vehicle-highway systems will require the most research. Reliability must increase and costs must decline before the technology will be ripe for such a system. Yet, strides are being made. Motorola Labs recently announced the breakthrough of a new chip design that will allow higher frequencies than the old circuitry. This will help to avoid problems with interference and also will help to lower the cost of the systems. Since cost was one of the most prominent obstacles mentioned by our experts—this breakthrough is significant.

Loop and Video Detectors: In order for the above elements to work, the infrastructure must be set to detect traffic volume, obstructions and weather conditions. Thus, these pieces to the puzzle are of vital importance. Virginia Tech

seems to be on top of this research, building a “Smart Road” as a research test bed.

Signal Control: Signal controls will be the key to automatically cut down on local congestion. This type of control is important for both Type 1 and Type 2 traffic.

Smart/Electronic Toll Collection Tags: Many of the innovations occurring in Intelligent Transportation Systems seem to be imperceptible to the general public. As the technologies of electronic toll collection and smart card fare make revenue collection more effortless—more fee-based transportation services will begin to proliferate. Sarah Joshua of Maricopa Association of Governments believed that user fees based on time of day, road type and distance would replace gasoline taxes within 15 years.

Dual-Mode Guideway Systems: While the experts downplayed the importance of these systems, VisionEcon begs to differ. With all the transformations occurring in the “New Economy” as mentioned earlier in this report, there will be incessant pressure to find faster, cheaper ways to move labor and goods around the globe. In addition, there will be incessant pressure for transportation providers to recover costs for transportation infrastructure. On top of those pressures, environmental pressures will continue to escalate encouraging an alternative to the gasoline engine. Yet, travelers will still want speed and freedom, customization and choice. The only way to accommodate all these requirements is through some type of dual mode transportation system.

While many of the dual mode transportation system designs reviewed are overlooking at least one of the four resistance factors mentioned earlier in the report, the dual-mode concept is still very solid. Travelers want speed and freedom. Manufacturers, planners and current transportation providers want to keep adaptations to a minimum. Costs need to be practical and measurable. But, most of all, the Internet has turned our globe into a smaller place. Thus, people want to be able to purchase goods they find on the Internet from half-way

around the globe. And, with a study of the subsequent generations completed in Phase 3 of this project—the next generations will become even more impatient for the delivery of their favorite products and people. Thus, pressures will build to merge some type of high-speed transportation alternative to the traditional trucking industry. Once again, Virginia Tech appears to be right on the mark with their PERTS system.

As mentioned in his article for The Futurist magazine, Francis D. Reynolds asserts that the dual mode concept has been envisioned by more than two dozen inventors. Thus, just as the concept of a locomotive steam engine motivated many innovators to continue to delve into the possibilities despite many failures before them, dual mode enthusiasts will persevere. And, one of these inventors will probably succeed just as George Stephenson succeeded with his revolutionary concept of the steam locomotive in 1822.

Conclusion

While transportation experts need to be reminded that this analysis was completed by an economist, it is clear that pressures will continue to build to create a transportation system that can move even more labor and goods with less congestion. On the surface it seems as though this mandate would represent an impossible wish list, but technologies are unfolding that could make such a system a reality.

In the meantime, transportation planners will benefit by working with communities to create more self-contained nodes that reduce the strain on traditional infrastructure for short, convenient and task-oriented trips. By freeing traditional infrastructure from this type of travel (Type 1), more resources can be dedicated to commuter/event travel (Type 2) and globalized travel (Type 3).

In this arena, the emerging innovations seem to point to the cooperative vehicle-highway system as the most likely victor in the transportation technology contest. This type of arrangement satisfactorily addresses the

resistance factors placed by travelers, manufacturers, planners, service providers and cost structures. Still, transportation planners will need to set up surveillance systems to keep tabs on the highly innovative transportation technology fields. This area will become an area of innovation in the future as globalization places intensified pressure on the transportation system to move goods more quickly and inexpensively. Any breakthrough in magnetic levitation or automatic throttling will dictate the landscape of future transportation.

Until then, a continuous perusal of the transportation R&D occurring around the globe will provide planners with pieces of the puzzle that will compose the portrait of future transportation. As it took almost 200 years of connected “stepping stones” to piece together the first steam locomotive, it will take years of innovational steps to help produce a new transport for the “New Economy”. But, many clues will be unveiled by inventors along the way—for those planners that take heed.

Table 7: Likely Victors in Transportation Technology

Technology	Contribution to Future Technology Transportation
Global Positioning Systems (GPS)	Location detection of specific vehicles
Telematics	Connects cars to each other and a central source
Adaptive Cruise Control and Other Collision Avoidance Systems	Development of multiple sensors (both radar and optical), and the practice of sensor fusion
Signal control	Technologies to provide automatic control of traffic
Loop Detectors and Video Detection Systems	Groundwork for other cooperative vehicle-highway information systems
Smart/Electronic Toll Collection tags	Quick, easy collection system for providing transportation services
Dual mode Transportation Systems	Travelers are granted both individuality and speed with a minimization of congestion

The full report: *Technology and Intelligent Transportation Systems (ITS): The Implications for Future Transportation* by Debra Roubik (Arizona Department of Transportation, report number FHWA-AZ-02-507(4), published June 2002) is available from the Arizona Transportation Research Center, 206 S. 17 Ave., Mail Drop 075R, Phoenix, AZ 85007; phone 602-712-3138; web page: <http://www.dot.state.az.us/ABOUT/atrc/Index.htm>.